Food Policy 49 (2014) 167–173

Contents lists available at ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

Rebound effects due to economic choices when assessing the environmental sustainability of wine

Graziella Benedetto [a], Benedetto Rugani [b], Ian Vázquez-Rowe [b,c,d,*]

[a] Department of Science for Nature and Environmental Resources, University of Sassari, Via Piandanna 4, I-07100 Sassari, Italy
[b] Public Research Centre Henri Tudor (CRPHT)/Resource Centre for Environmental Technologies (CRTE), 6A avenue des Hauts-Fourneaux, L-4362, Esch-sur-Alzette, Luxembourg
[c] Peruvian LCA Network, Department of Engineering, Pontificia Universidad Católica del Perú, Avenida Universitaria 1801, San Miguel, Lima 32, Peru
[d] Department of Chemical Engineering, School of Engineering, University of Santiago de Compostela, 15782 Santiago de Compostela, Galicia, Spain

ARTICLE INFO

Article history:
Received 4 October 2013
Received in revised form 8 July 2014
Accepted 31 July 2014

Keywords:
Carbon footprint
Consequential LCA
Indirect effects
Life Cycle Assessment
Sustainable consumption

ABSTRACT

The identification and working mechanisms of Rebound Effects (REs) have important policy implications. The intensity of these impacts is crucial when it comes to detecting strategies to promote sustainable consumption of food and beverages, as in the case of wine. In fact, neglecting the occurrence of REs in wine production and delivery leads to under- or over-estimating the effects that novel more sustainable technologies may produce. An in-depth analysis on the ways in which the stakeholders may react to the availability of a new product (e.g. wine produced through a process oriented to the reduction of CO_2 emissions) may be particularly useful to allow producers and consumers to target the REs with respect to the overall goals of desired sustainability. In this article, we first provide a definition and a classification of different types of REs and then analyse some exemplificative cases applied to the supply and consumption of wine produced through technologies that reduce environmental emissions or resource consumptions. A final step analyses the methodological tools that may be useful when including REs in life cycle thinking as applied to the wine sector.

Introduction

Growth in economic activities originating as a consequence of the increase in production efficiency generates a phenomenon commonly referred to as the Rebound Effect – RE (Hertwich, 2005; Sorrell and Dimitropoulos, 2008). More specifically, the RE describes intensifications of resource or energy efficiency that do not necessarily result in a corresponding decrease in energy or resource use (Binswanger, 2001).

While historically associated with the study of energy use, the topic of REs plays a significant role in the debate regarding the quantification of environmental impacts (i.e. resource use, pollutant emissions or generated wastes) using environmental management tools (Chitnis et al., 2013; Druckman et al., 2011). An example of these tools is the Carbon Footprint – CF indicator (BSI, 2011), which originates from the standardized and broadly accepted Life Cycle Assessment (LCA) method (ISO, 2006). Both CF and LCA aim, among other environmental management methodologies, at elucidating on whether the introduction of a technical, apparently more sustainable, innovation in the product's supply-chain may lead to a real environmental improvement of the entire life cycle. In doing so, the product in question is intended to become more 'eco-compatible' than its traditional counterpart.

In contrast with this steady-state view, which matches the perspective covered by *attributional* LCA studies (EU, 2010), it is worth considering an evolutionary (dynamic) view in which the possible reactions on the market due to the implementation of this 'new' product are quantified and analysed (Giampietro and Mayumi, 2008). In fact, the latter fits in with the strategy followed in *consequential* LCA (CLCA), a life cycle approach that intends to raise the utility of LCA studies (e.g. policy making) by monitoring the environmental consequences of a change (UNEP, 2011). In addition, the identification of REs and their functionality mechanisms underlies important policy implications. The dimension of these effects is essential when the aim is to establish strategies to implement sustainable production and consumption patterns.

In general, neglecting REs may result in an under- or over-estimation of the environmental and economic impacts that new sustainable technologies can provide at a broader scale (Chitnis et al., 2013). An in-depth analysis on the ways producers, on the one

* Corresponding author at: Peruvian LCA Network, Department of Engineering, Pontificia Universidad Católica del Perú, Avenida Universitaria 1801, Lima 32, Peru. Tel.: +51 626 2000 4765.
E-mail address: ian.vasquez@pucp.pe (I. Vázquez-Rowe).

http://dx.doi.org/10.1016/j.foodpol.2014.07.007
0306-9192/

hand, and consumers, on the other, may respond to the availability of a new production technology or a new product is essential to address the overall targets of desired sustainability to understand which might be the activity levels to be expected from this improvement.

An interesting example is the wine sector, which has recently experienced a set of development actions addressed to perform a requalification of the supply-chain and labelling through the implementation of sustainable production models. For instance, Commission Regulation (EC) No. 607/2009, which develops Council Regulation No. 479/2008, advances a new framework for the labelling and presentation of certain wine products, which will have a direct effect on the European organisation of the wine market in the revised Common Agriculture Policy (CAP) 2014–2020. This new framework is expected to increase the wine niche markets, by introducing important modifications in the viticulture (e.g., adaptation of vineyards to organic and/or biodynamic practices) and packaging stages (e.g. the use of lighter bottles) along the supply chain. In fact, the implementation at a small scale of some of these actions have led to subsequent variable changes in the costs of winemaking and, therefore, in the final price paid by consumers. For instance, while CF studies on wine production suggest that the associated GHG emissions are lower when using PET bottles rather than glass (Point et al., 2012; Vázquez-Rowe et al., 2012), the related reduction of costs has increased the exportability of wine and, therefore, increased at the same time the overall life cycle carbon emissions caused by transportation, as well as the final price at retailing (Waye, 2008).

Based on this background, the main aim of this article is to examine the concept of REs in the context of sustainable wine production (i.e. wine produced with technologies capable of reducing the consumption of resources and the emission of pollutants and wastes), while defining a roadmap to address current open questions about the assessment of REs in CF and LCA of wine through a CLCA approach. Analysing wine rather than other food or drink products that are more essential in the human diet (e.g. dairy or cereal-based products) has been considered effective in this article since wine products currently tend to go beyond national economic boundaries. This circumstance strongly influences price and market worldwide, making wine an interesting example due to its complex REs implications. Nevertheless, beyond the focus on the wine sector presented in this article, discussion attempts to explore the importance of REs in the food and beverages sector from a life-cycle perspective.

The structure of the article is centred on the definition and classification of REs and the related economic and environmental implications associated with the inclusion of a possible technological innovation on the micro- and macro-level of the wine market, considering factors that influence the supply and demand of wine and their inter-relationship (e.g. the elasticity of price and income at the consumption's demand scale).

Rebound Effects: theoretical background

In the field of energy economics and savings, the RE (or *take-back*) refers to specific systemic responses that originate from the introduction of more efficient technologies in the production cycle. As a result, the positive effects attained with the new technology are generally counterbalanced due to the continuous dynamic adaptation of the economy to its own structures (Giampietro and Mayumi, 2008). For instance, Berkhout et al. (2000) state that a RE of 10% implies that *10% of the energy efficiency improvement initiated by the technological improvement is offset by increased* consumption (p. 426). Extreme cases occur when the RE is higher than 100% (Jevons' paradox or *backfire*) or even when the RE turns out to be negative (defined as *super-conservation*) due to larger than expected effective savings (Jevons, 1865; Wei, 2010).

In the field of LCA and environmental-economic accounting, Weidema (2008) defines REs as "*[...] the derived changes in production and consumption when the implementation of an improvement option liberates or binds a scarce production or consumption factor, such as: (a) money (when the improvement is more or less costly than the current technology); (b) time (when the improvement is more or less time consuming than the current technology); (c) space (when the improvement takes up more or less space than the current technology), or d) technology (when the improvement affects the availability of specific technologies or raw materials)*" (p. 1). Moreover, he distinguishes between three types of REs: (1) "specific", occurring when production and consumption of the product analysed changes; (2) "general", which takes place when the overall production and consumption changes; and (3) "behavioural", when the organisation of production and consumption changes, affecting both the product under study and other related products.

REs are relevant at a producer scale as well as from the point of view of the consumer. Accordingly, it is worth recalling the definition given by Sorrell (2007a; p.5) concerning two other potential targets in which the direct REs can be decomposed:

- in the case of producers, REs can be separated in two groups: "substitution effect REs" (*whereby the cheaper energy service substitutes for the use of capital, labour and materials in producing a constant level of output*) and "output effect REs" (*whereby the cost savings from the energy efficiency improvement allow a higher level of output to be produced – thereby increasing consumption of all inputs, including the energy service*);
- in the case of consumers, REs are also divided in two types: "substitution effect REs" (*whereby consumption of the (cheaper) energy service substitutes for the consumption of other goods and services while maintaining a constant level of 'utility' or consumer satisfaction*) and "income effect REs" (*whereby the increase in real income achieved by the energy efficiency improvement allows a higher level of utility to be achieved by increasing consumption of all goods and services, including the energy service*).

Substitution REs driven by consumer choices are valid for all consumption goods where the substitution effect is the most evident factor to explain the negative slope of the demand through the analysis of indifference curves (Samuelson and Nordhaus, 2002). In other words, the substitution effect shows that when the price of a good increases, consumers tend to choose other goods to satisfy their needs at a lower cost. In contrast, the income effect informs on the impact that a variation in price may have on the demand of goods which results from the effect of price variations on the actual income of consumers. In this respect, companies follow the same behavioural approach: the supply curve is influenced by the costs of production, which in turn are influenced by the prices of inputs and technological progress. In the short-term, an increase in input prices implies an increase in costs, and thus a reduction in supply; while in the medium- to long-term, the reduction in price for some inputs may induce firms to replace the inputs that became relatively more expensive with those new factors, translating into a supply increase (Samuelson and Nordhaus, 2002).

Finally, a "macro" effect also exists and cannot be neglected due to the transition towards a low carbon emissions economy. In fact, this opens many new opportunities of economic expansion, by generating new fast-growing markets (e.g. in the field of renewable energy production) that represent potential sources of development for companies, sectors and entire nations.